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Engineering Note

Date: 3/11/99
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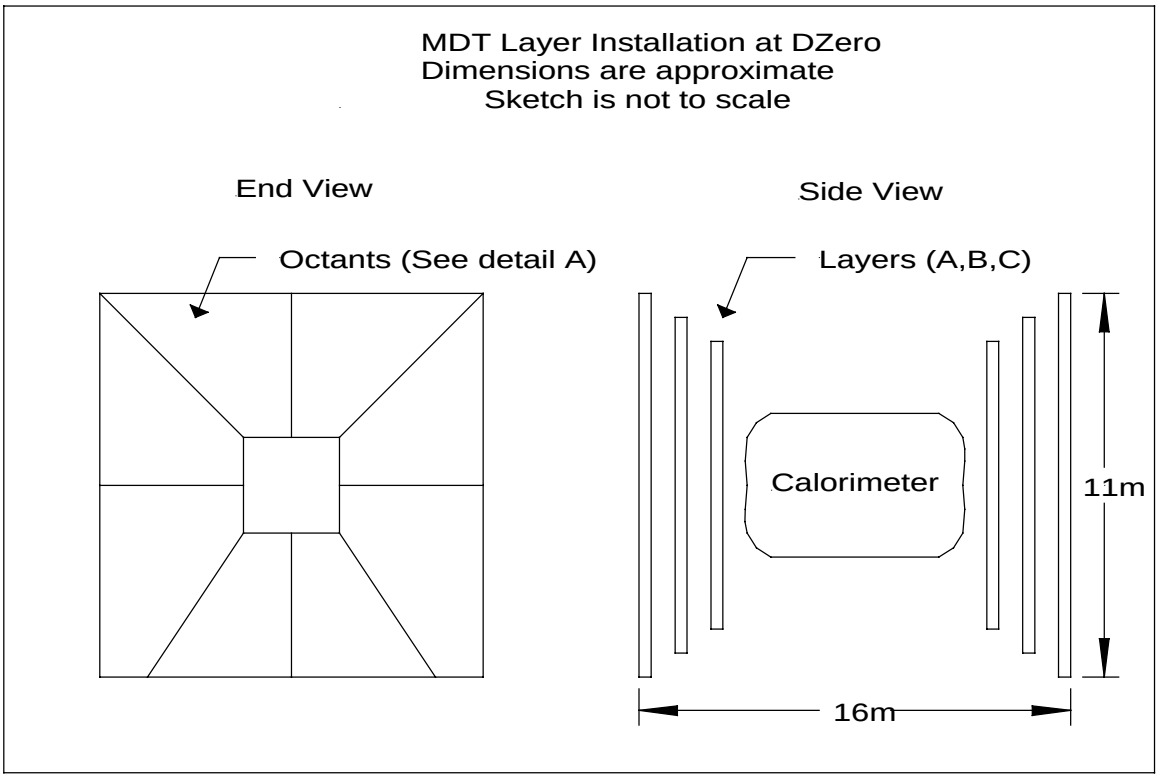
Project: Muon Mini Drift Tube (MDT) Installation
Doc. No: H990311A

Subject: Muon MDT Power Distribution

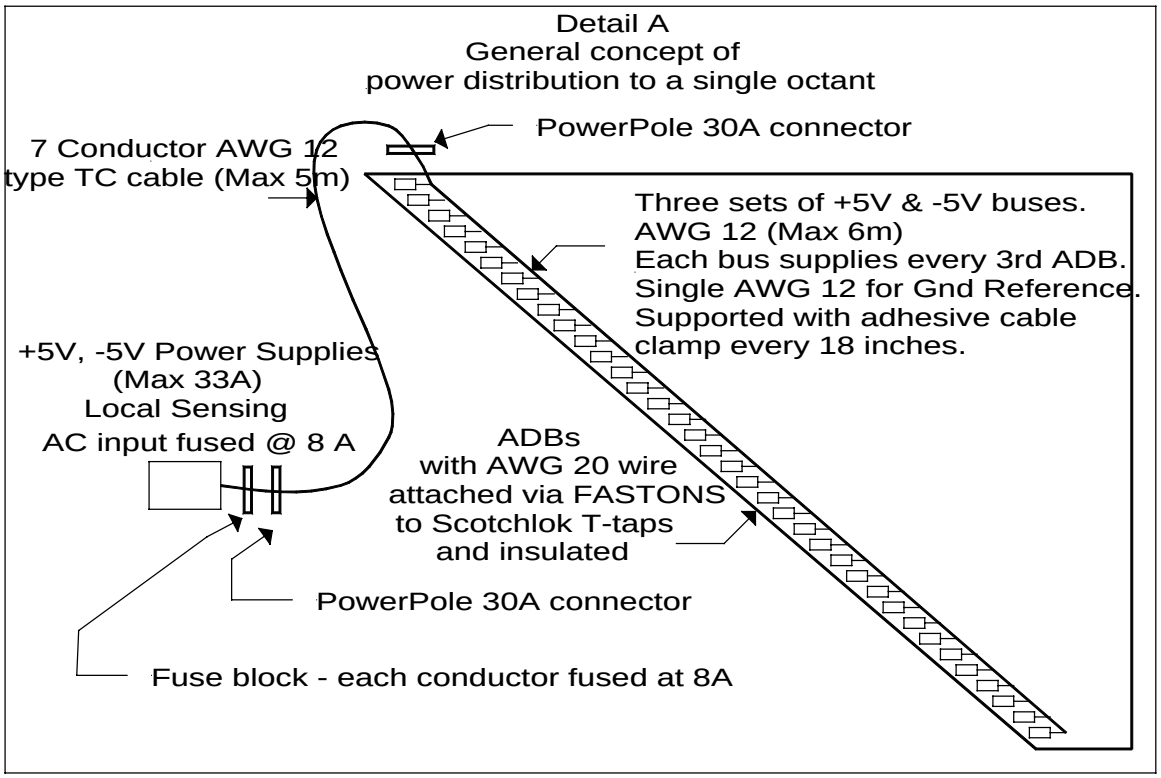
This note and its supplemental documents describe the low voltage dc power distribution scheme intended to deliver power to the Amplifier/Discriminator Boards (ADBs) in the Dzero Mini Drift Tube (MDT) system.

General Information:

There will be three layers of MDT detectors mounted on each of the north and south ends of the Dzero detector. The layers are defined as A, B, and C. The A layer will be closest to the calorimeter. Each layer will be comprised of eight octants; and each octant will have as many as 36 ADBs. The ADBs are 3" X 5" printed circuit boards containing a few components. They will be spaced along an edge of each octant so as to process signals from the MDTs. Each of these ADBs will require approximately 0.5 Amps of current at ±5 Volts. The general configuration of the octants and layers is illustrated below:



Detail A shows the concept of the power distribution scheme for each individual octant. Remotely located +5V and -5V "power paks" will provide current to each octant. An octant may have as many as 36 ADBs installed.



Requirements:

- The design must meet all Fermilab electrical safety standards and all components must be rated for the maximum currents and temperatures they will be exposed to.
- The voltage at each ADB must be within 0.2V of all the others.

Discussion of implementation:

The ADB module was designed and manufactured before the distribution system was seriously considered. Thus the design of the distribution system has been done "bottom up" starting with the ADB. The ADB contains positive temperature coefficient (PTC) devices rated at 0.90 Amp I_{hold} and 1.80 Amps I_{trip} to protect the printed circuit board and its components. The ADB's power connector header is a Molex Micro-Fit 3.0, which is rated at 5.0 Amps per, pin. This header is protected by the circuit board's PTCs, which are located very close to it. The connector that plugs into this header is the female type and is satisfactorily protected from inadvertent shorts by its encapsulated and recessed design. Its contacts accept a maximum wire size of AWG 20. These wires will be AWG 20 hookup wire rated at 600V, 105° C, VW-1 flame resistance. AWG 20 wire in bundles of 3 conductors are rated to carry only 8 Amps[1]. For a safe installation, these conductors must either be fused at 8 Amps or connected to a bus that is limited to no more than 8 Amps. There will be as many as 1500 ADBs in the 48 octants and they will be inaccessible once the detector is closed. Fusing the individual ADB taps is not desirable in order to avoid nuisance trips of fuses in inaccessible areas.

Furthermore, with as many as 36 ADBs per octant, each requiring ±5.0V @ 0.5 Amps of current for a total of 18 Amps, it is obvious that all 36 can not be connected to the same distribution bus fused at 8 amps. Therefore, three buses will be used on each octant. Each bus will be fused at 8.0 Amps, and each bus will provide power to 1/3 of the ADBs on an octant. Each bus will thus be loaded to no more than 6.0 Amps (12 ADBs/bus X 0.5 Amps/ADB). The ADB connections will be alternated and evenly distributed over the length of the three buses. This will allow minimum size conductors to be used yet still maintain the voltage differential among the ADBs to ≤ 0.2V. Calculations show the minimum conductor size required to

[1] Fermilab Electrical Design Standards For Experiment Apparatus Rev 4.0 10/16/98.

manage the voltage drop to be equivalent to AWG 12 (0.00513sq. in.)[2]. In addition to the ±5V power supply, a single conductor will provide ground reference and return for imbalance currents to the ADBs on all three buses.

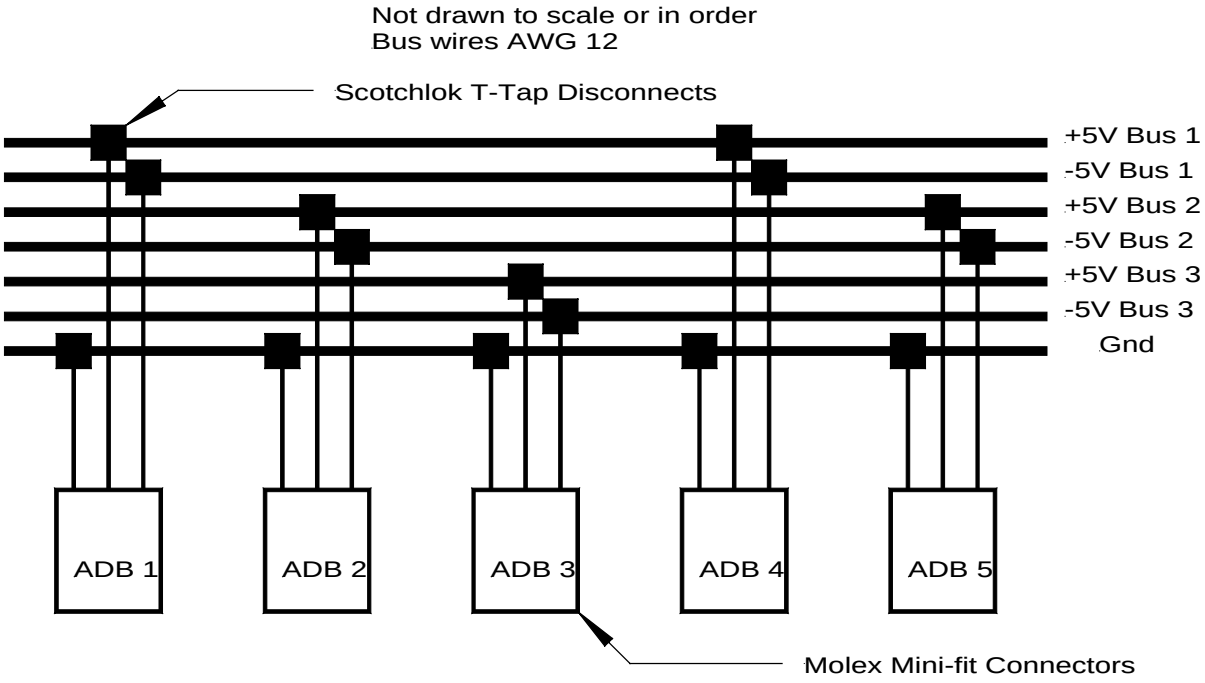
The three buses and single ground conductor on each octant will be brought directly to a 7-pole 30A per contact Anderson PowerPole connector at the end of the octant. From there, a 7 conductor, AWG 12, type TC (vertical tray rated) cable, which may be as much as 5 meters in length, will connect to a fuse block on the power supply assembly located in the detector trusses. The 30A rated fuse block will contain 8.0A fuses which will thus protect the AWG 20 wire at the ADB taps on the octant. The power supplies will not use remote sensing. This is possible due to extremely stabile loading of the ADB modules over the temperature and operating parameters.

Two 5 V power supplies will be connected in series and grounded at the center to the power supply chassis with an AWG 12 conductor. The AC inputs of the power supplies will be fused at 8.0 Amps per the manufacturer's instructions, and the power supplies will be fitted with 3.0 meter long SVT 18-3 line cords with grounded plugs. The grounded conductor (green wire) will be connected to the power supply chassis. The power supplies will be plugged into grounded duplex outlets that will be fed from 20 Amp circuits. Several duplex outlets will share each circuit.

Bus Details:

The buses will consist of AWG 12 PVC hookup wire rated at 600V, 105° C, VW-1 flame resistance. The tap connections will be made with 3M Scotchlock T-Tap disconnect terminals rated at 20 A. The ADB taps will be located strategically along the bus. The strategic locations of the taps are designed to connect each bus to every third ADB for voltage drop control. The ADB tap wires will be crimped into .250 X .032 male disconnects, plugged into the T-Taps, and insulated with 6:1 adhesive polyolefin heat shrink tubing.

All bus assemblies will be secured to the octants with adhesive PVC cable clamps. The adhesive clamps are rated to carry 1 lb. Continuous sheer load. The 7 AWG 20 wires used to construct the bus will weigh 0.217 pounds per foot of bus[3]. A clamp positioned every 18 inches is rated for 3 times the load it will have to carry ie. 1 lb /(0.217 lb/ft X 1.5 ft)= 3.07.



[2] Engineering Note H990202A, Rick Hance, 2/17/99.

[3] Engineering Note H990406A, Rick Hance, 4/6/99

Supplemental Documentation:

The supplemental documentation shows all details of wire sizes & ratings, terminal ratings, part specifications etc. The schematic diagram is the basic reference document. All documents are available on the www at URL:

http://www-d0.fnal.gov/~hance/mdt.htm

- Schematic diagram of installation (3 sheets). Drawing #3823-133-EB-330279.
- Database "\\D0-rickh\C:\Data\MDT Power\MDT Power Distribution.mdb" - parts list.